Cornell-Dubilier Electronics
South Plainfield, New Jersey

PRELIMINARY CONCEPTUAL SITE MODEL (CSM)
CORNELL-DUBILIER ELECTRONICS SUPERFUND SITE
SOUTH PLAINFIELD, NEW JERSEY

HydroQual

Environmental
Engineers & Scientists

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SECTION 1

INTRODUCTION

The Cornell-Dubilier Electronics, Inc. (CDE) Superfund Site, (EPA ID# NJD981557879) (the "Site") is located at 333 Hamilton Boulevard, Borough of South Plainfield, Middlesex County, New Jersey (Figure 1). The former CDE facility, now known as the Hamilton Industrial Park, consists of approximately 26 acres containing 18 buildings that are currently used by a variety of commercial and industrial tenants. EPA has divided the remediation associated with the Site into separate phases, or operable units. Operable Unit 1 (OU-1) consists of residential, commercial, and municipal properties located in the vicinity of the former CDE facility. Operable Unit 2 (OU-2) addresses the contaminated soils and buildings at the former CDE facility, including soils that may act as a source of groundwater contamination. Operable Unit 3 (OU-3), the focus of this report, consists of investigating the nature and extent of potential groundwater and soil vapor impacts.

Dana Corporation entered into an *Administrative Settlement Agreement and Order on Consent for Remedial Investigation/Feasibility Study* (Settlement Agreement) for OU-3 (Docket No. 02-2005-2024). The Settlement Agreement provides for a series of tasks for completion of a Remedial Investigation (RI) and Feasibility Study (FS), the first of which is the development of a preliminary Conceptual Site Model (CSM) as an aid for project planning. The objective of this document is to summarize and evaluate Site information obtained as part of prior site investigations (e.g., OU-1 and OU-2 work) and regional studies to develop a preliminary CSM. The preliminary CSM presented herein will be revised and updated as new information is obtained during the OU-3 investigation.

Section 2.0 describes the physical setting of the Site including Site history as well as current and proposed land use, while Section 3.0 discusses the Site geology and hydrogeology. Information related to potential contaminant sources, constituents of concern, and exposure pathways are discussed in Sections 4.0 and 5.0. The available data are then evaluated to develop the CSM presented in Section 6.0 and specific data needs are identified in Section 7.0

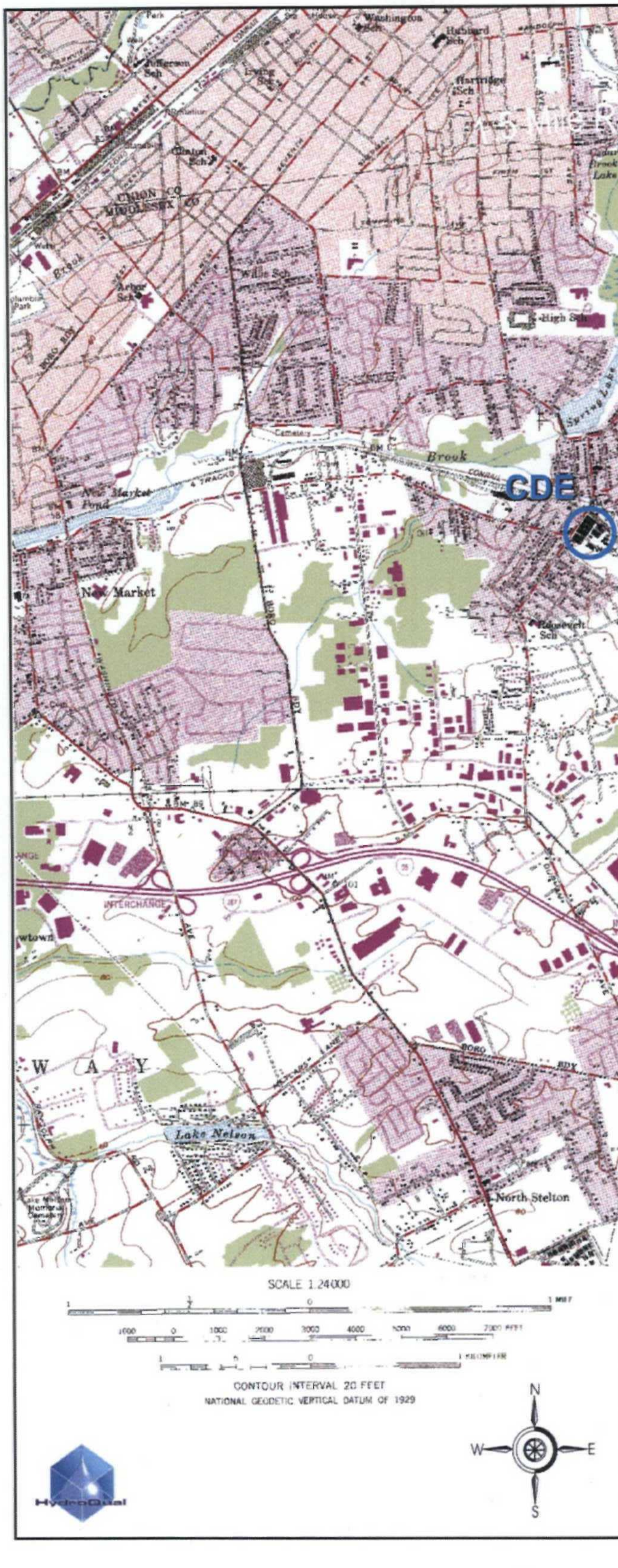


Figure 1

Site Location Map

Cornell-Dubilier Site
South Plainfield, NJ

HydroQual, Inc.

SECTION 2

PHYSICAL SETTING AND LAND USE

2.1 SITE DESCRIPTION

The Site is located in the Borough of South Plainfield, northern Middlesex County, in the central portion of New Jersey. According to the 2002 Census, South Plainfield has a population of approximately 22,896 people with a total land area of approximate 8.4 square miles (city-data.com).

The Site consists of a fenced, 26-acre facility that is bounded on the northeast by the Bound Brook and the former Lehigh Valley Railroad, Perth Amboy Branch (presently Conrail); on the southeast by the Bound Brook and a property used by the South Plainfield Department of Public Works; on the southwest, across Spicer Avenue, by single family residential properties; and to the northwest, across Hamilton Boulevard, by mixed residential and commercial properties (See Figure 1). The surrounding area represents an urban environment with principally commercial and light industrial use to the northeast and east, principally residential development to the south and directly north, and mixed residential and commercial properties to the west.

The Site can best be described as two separate areas. The northwest, or developed area of the Site, is characterized by buildings and roadways, and comprises approximately 40 percent of the land area. Approximately 18 structures are located in this area, often subdivided into separate units that are leased to various tenants. In general, open areas on this portion of the Site have been paved as part of prior removal actions, with only small, fenced in areas of vegetation remaining. A system of catch basins is present throughout this area that channels stormwater flow to two outfalls along the Bound Brook. Investigations have indicated that some of the building interior floor drains also discharged to these catch basins.

The southeast, or undeveloped area of the Site, is predominately vegetated with a fenced semi-paved area in the middle. The Bound Brook flows from the eastern corner across the northeastern border of this area. Comprising approximately 60 percent of the land area, the undeveloped portion is separated from the developed portion by a chain-link fence with locked gates. The central area of this portion is relatively flat and is primarily an open field, with some wooded areas to the northeast and south and the semi-paved area in the middle. Beyond this area, the topography drops steeply to the northeast and southeast, and consists primarily of wetland areas bordering the Bound Brook. Elevations range from approximately 71 feet above msl at the top of the bank to approximately 60 feet above msl along Bound Brook.

2.2 SITE HISTORY AND PREVIOUS INVESTIGATIONS

The first recorded industrial use of the Site was by Spicer Manufacturing Corp., who owned and operated the facility from 1912 to 1929, after which it ceased operation in South Plainfield. Many of the buildings on the Site were constructed in 1918 to support Spicer's manufacture of various automobile industry parts such as universal joints, clutches, etc. Beginning in 1936, the property was leased to CDE, which manufactured electronic components from 1936 to 1962. In 1956, CDE purchased the property and owned it until 1962 when it was sold to D.S.C. of Newark Enterprises Inc. (DSC). Since DSC's purchase of the property, the former CDE facility, now known as the Hamilton Industrial Park, has been leased to an estimated 100 tenants and is currently used by a variety of commercial and industrial tenants. In December 2001, the South Plainfield Borough Council designated the Hamilton Industrial Park and certain lands in the vicinity of the industrial park as a "Redevelopment Area". The Borough retained a planning consultant to prepare a redevelopment plan for the designated area and has designated a developer to implement the plan.

Environmental conditions at the Site were first investigated by NJDEP in 1986. Since that time, sampling conducted by NJDEP and USEPA showed the presence of elevated levels of PCB's, VOC's and inorganics in Site soils, sediments and surface water. In 1997, USEPA conducted a preliminary investigation of the Bound Brook and also collected surface soil and interior dust samples from nearby residential and commercial properties. These investigations lead to fish consumption advisories for the Bound Brook and its tributaries. As a result of these sampling activities, the Site was added to the NPL in July 1998. In addition, based on data collected on and off-site, USEPA ordered several removal actions to be performed, as follows:

- In March 1997, EPA ordered DSC, as the owner of the facility property and a potentially responsible party (PRP), to perform a removal action associated with contaminated soil and surface water runoff from the facility. The removal action included paving driveways and parking areas in the industrial park, installing a security fence, and implementing drainage controls.

- In 1998, USEPA initiated a removal action to address PCBs in interior dust at houses to the west and southwest of the Site.

- In 1998, EPA ordered DSC and CDE to implement a removal action to address PCBs in soils at six residential properties located to the west and southwest of the Site. This removal action was conducted by CDE from 1998 to 1999.

- In 1999, EPA ordered CDE and Dana to implement a removal action to address PCBs in soils at 7 residential properties located to the west and southwest of the Site. This removal action was conducted from 1999 to 2000.

- In April 2000, EPA entered into an AOC with DSC requiring the removal of PCB-contaminated soil from one additional property located on Spicer Avenue. DSC agreed to perform the work required under the AOC, but subsequently did not do so. In August 2004, EPA began the removal of PCB-contaminated soil from this property, and the work was substantially completed in September 2004.

In 2000, Foster Wheeler, under contract to USEPA, implemented a remedial investigation (RI) that included the collection of on- and off-site soil and sediment samples, on-site building surface samples, and on-site groundwater samples. These data were compiled in the *Data Evaluation Report for Cornell-Dubilier Electronics Superfund Site, South Plainfield, Middlesex County, New Jersey* (Foster-Wheeler, 2001). Subsequent to initiating the RI, USEPA divided the Site into three operable units (OUs): OU-1 addresses impacted properties in the vicinity of the Site; OU-2 addresses impacted on-site soils and buildings; and OU-3 addresses impacted groundwater. The RI and Feasibility Study (FS) for OU-1 were issued by USEPA in 2001. In June 2003, USEPA proposed a remedy for OU-1, and the Record of Decision (ROD) for OU-1 was issued on September 30, 2003. The selected remedy projects the removal of approximately 2,100 cubic yards of impacted soils from neighboring properties as well as indoor dust remediation where PCB contaminated dust was encountered. Additional sampling (soil and dust) is also planned to determine if further remediation is required

The RI Report for OU-2 was issued in August 2001. The FS for OU-2 was then issued in April 2004, and the ROD was issued in September 2004. The remedy specified in the ROD contemplates the excavation and on-site treatment and/or off-site disposal of an estimated 107,000 cubic yards of soils containing PCB concentrations greater than 500 ppm, or other contaminants containing concentrations above New Jersey's Impact to Groundwater Soil Cleanup Criteria (IGWSCC), plus an additional estimated volume of 7,500 cubic yards of contaminated soil and debris from the capacitor disposal areas. Following excavation, the Site will be regraded and capped. Demolition of the 18 on-site buildings will also be completed with appropriate off-site disposal of the debris.

Completion of the remedial actions identified for OU-1 and OU-2 is currently pending.

SECTION 3

GEOLOGY AND HYDROGEOLOGY

3.1 GEOLOGY

The Site lies within the Piedmont Physiographic Province and is underlain by a relatively thin layer of soils comprised of quarternary glacial deposits and artificial fill. These unconsolidated deposits overlie the late Triassic to early Jurassic Age Passaic Formation (formerly Brunswick Formation) of the Newark Group.

The overburden soils range in thickness from 0.5 to 15 feet and generally thicken towards the Bound Brook. The natural soils represent a mix of red-brown silt and sand as well as silt and clay layers, with a generally consistent weathered siltstone unit immediately above bedrock that consists predominantly of red-brown silt to fine sand, with sub-rounded to angular, fine to coarse siltstone gravel and silty clay. This weathered zone interfingers with urban fill material at a number of locations on the Site. The fill material generally consists predominately of cinders, ash, brick, glass, metal, slag, and wood fragments.

The top of the consolidated Passaic Formation bedrock generally ranges from 4 to 15 feet below ground surface, except in the far northwest corner of the Site, where bedrock is found immediately underlying the building slabs. The surface of the bedrock generally slopes to the south-southeast and consists of red-brown to purplish-red mudstone and siltstone with localized beds of fine-grained sandstone. These sedimentary units generally strike to the northeast and dip between 5 and 15 degrees to the northwest, with primary fracture patterns both parallel and perpendicular to bedding (Lewis-Brown and dePaul, 2000). Rock cores collected on-site were noted to contain heavily fractured zones, generally occurring along bedding planes.

3.2 HYDROGEOLOGY

The thin unconsolidated materials overlying bedrock exhibit discontinuous zones of perched water that do not constitute an aquifer at the Site. These discontinuous zones of perched water occur frequently where unconsolidated natural and fill materials of variable composition interfinger. The depths of the perched zones are variable across the Site, although they typically occur in the range of 4 to 8 feet below ground surface. In comparison, the potentiometric surface of the shallow bedrock, the regional water table, typically ranges from 11 to 20 feet below ground surface. The layers of silt, clay, and weathered siltstone, comprising the overburden/top of bedrock zone, provide the relative resistance to vertical flow that allows these perched zones to occur during sufficiently wet periods.

The underlying Passaic Formation represents a multi-unit leaky aquifer system that consists of interbedded siltstone, mudstone and shale. Groundwater flow within the Passaic Formation is primarily through secondary permeability associated with interconnected fractures. By comparison to this secondary permeability, the unit, as a result of compaction and cementation, has limited porosity and permeability. The upper 50 to 60 feet of the Passaic, however, is typically weathered such that the fractures are generally filled with low permeability silt and clay that limits the hydraulic conductivity of this zone. This upper weathered zone is typically unconfined and represents the upper most contiguous water-bearing zone beneath the Site. Below this zone, the Passaic is typically semi-confined and can yield significant quantities of water. Groundwater flow is controlled by the degree of fracturing and the anisotropy of the formation, which results from the typically higher values of hydraulic conductivity along the direction of strike (generally to the northeast). The magnitude of this anisotropy can play a significant role in controlling groundwater flow direction.

Mapping of the potentiometric surface within the upper weathered zone beneath the Site suggests groundwater flow to the northwest. In addition, stream gauge measurements in the Bound Brook typically indicate higher head levels than those in nearby bedrock wells, suggesting that the Bound Brook is recharging the upper bedrock aquifer and does not represent a groundwater discharge point. The groundwater discharge point for the Passaic formation is likely represented by the large number of municipal water supply wells located north of the Site along a broad swath of the aquifer located south of the Watchung Ridge.

SECTION 4

POTENTIAL CONTAMINANT SOURCES AND CONTAMINANTS OF CONCERN IN GROUNDWATER

Potential contaminant sources and contaminants of concern in groundwater are discussed below in relation to both the Site and other potential sources. Impacts to off-site properties, on-site soils and buildings, and sediments are being addressed by EPA as part of separate operable units.

4.1 SOURCES ON THE CDE SITE

During the period of its operations, CDE is reported to have disposed of PCB-contaminated materials and other substances directly on the facility soils, and previous Site investigations indicate elevated concentrations of VOCs, SVOCs, PCBs, and metals in the on-site soils and sediments. Groundwater analytical results indicate elevated levels of VOCs and PCBs, with PCBs present likely as a result of cosolvency effects due to high VOC concentrations as well as suspended solids. Soils containing elevated levels of VOCs and PCBs thus appear to represent a source to groundwater. However, metals found at elevated levels in the soils were not found in the groundwater. Therefore, soils impacted by metals do not appear to be a source to groundwater. SVOCs detected in soils were also not routinely detected in groundwater and also do not appear to be a source to groundwater.

Compounds detected in groundwater beneath the Site include the following:

Compound	Minimum Detected Concentration (PPB)	Maximum Detected Concentration (PPB)	Frequency of Detection
Volatile Organics (VOCs)			
Trichloroethene (TCE)	17	120,000	12/12
Cis-1,2-Dichloroethylene	2	190,000	12/12
Tetrachloroethene (PCE)	12	520	3/12
Vinyl Chloride	9	160	3/12
1,2,4-Trichlorobenzene	1,200	1,200	1/12
Semi-Volatile Organics (SVOCs)			
Naphthalene	5	5	1/12
Bis(2-Ethylhexyl) phthalate	1	1	1/12
Pesticides and PCBs			
beta-BHC	.016	.016	1/12
delta-BHC	.074	.074	1/12
Aldrin	.022	1.3	9/12
PCB – Aroclor 1232	.53	80	9/12
PCB – Aroclor 1254	4.1	9.2	4/12

Note: Inorganics (metals) found at elevated concentrations in the soils were not elevated in groundwater. Inorganics were detected as naturally occurring elements.

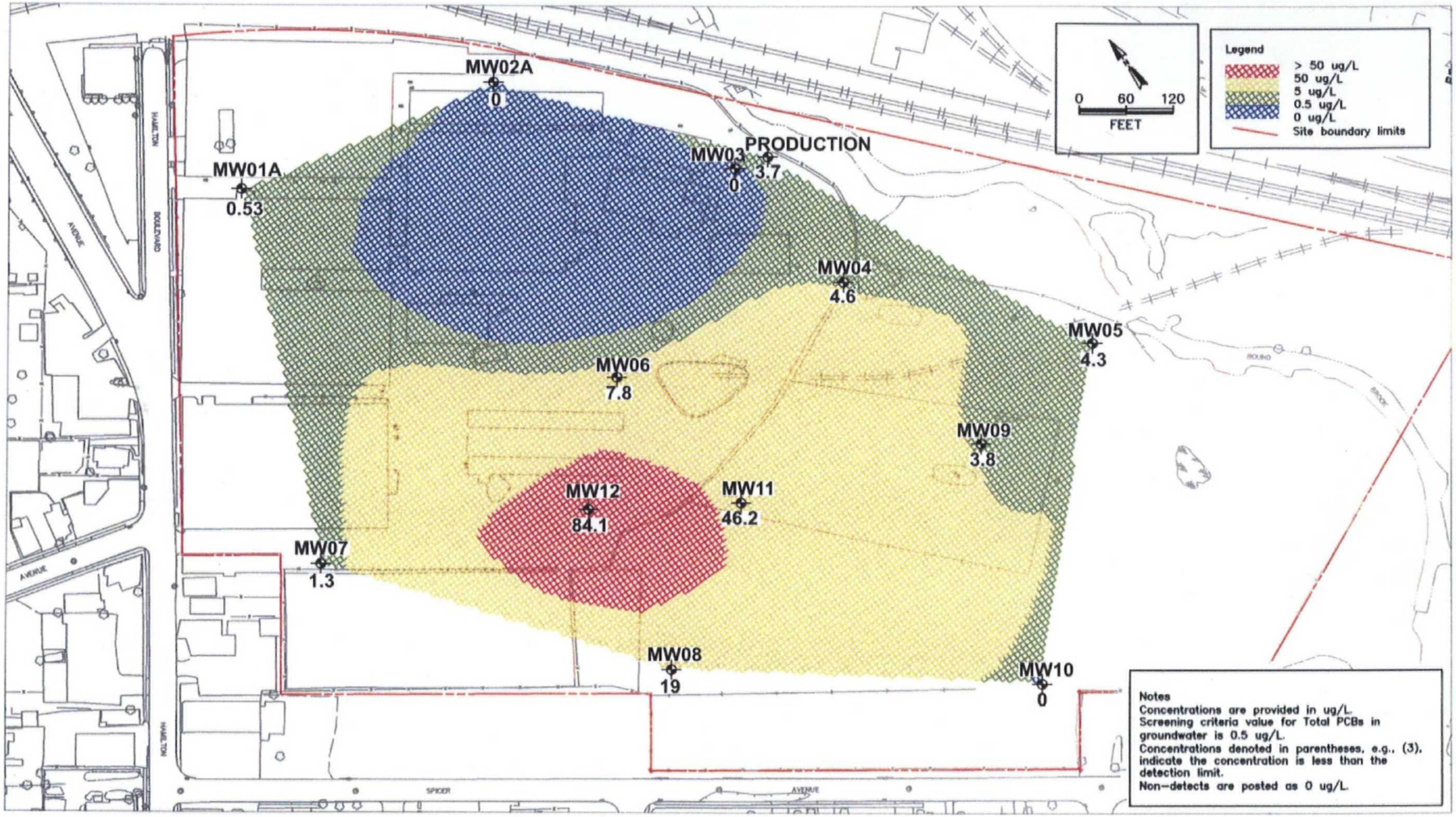
As summarized above, trichloroethene (TCE) and its degradation product cis-1,2-dichloroethene (Cis-1,2-DCE) represent the compounds most frequently detected and at the highest reported concentrations on the Site, followed by PCBs and the pesticide aldrin. The distribution of PCBs and VOCs in shallow bedrock groundwater beneath the Site is illustrated in Figures 2 and 3 respectively.

As discussed previously in Section 3.0, work completed to date indicates that surface water elevations in the Bound Brook are above the potentiometric surface in nearby bedrock wells. These data indicate that groundwater does not discharge to the Bound Brook. Therefore, impacts to sediments in the Brook are unrelated to groundwater and are likely related to surface water runoff and discharge from the Site's interconnected floor drains and stormwater catch basins that discharged to two locations along the Bound Brook. PCBs, VOCs, SVOCs, pesticides, and metals were detected in sediment and standing water samples collected from these catch basins. Previous Site stabilization measures (i.e., paving and silt fencing) that were implemented by the property owner in 1997 addressed the potential for Site contaminants to reach the Bound Brook via overland runoff and through the facility drainage system discharges.

4.2 OTHER POTENTIAL SOURCES

Investigations by NJDEP between January 1987 through October 1990 identified the presence of chlorinated solvents, most notably trichloroethene (TCE) and tetrachloroethene (PCE), in residential wells located to the south, southwest and west of the Site (Pitt Street Private Well Study Area). The distribution of TCE in bedrock groundwater, the most frequently detected constituent, is illustrated in Figure 4. Other detected VOCs included the PCE/TCE breakdown products of 1,2-dichloroethene, 1,1-dichloroethene, and vinyl chloride as well as 1,1,1-trichloroethane, carbon tetrachloride, methyl-tert-butyl ether (MTBE), chloroform, and xylene.

The sources of the VOCs identified above have not been determined. However, searches of the NJDEP Comprehensive Site List (CSL) and Environmental Data Resources Inc. (EDR) databases yield over one hundred sites within approximately 1 mile of the Pitt Street Private well area that may be considered as potential sources of VOCs in groundwater. Sites in the area at which chlorinated solvents have been detected include, but are not limited to, Mary Kay Cosmetics, Prosoco Inc., Hummel Chemical, Asarco, Modulume, and others. Groundwater investigations at several different facilities in the area by various consultants have identified a regional groundwater problem in the South Plainfield area with much of the area to the southwest of the CDE Site identified by NJDEP as a classification exception area (CEA) (Figure 5).



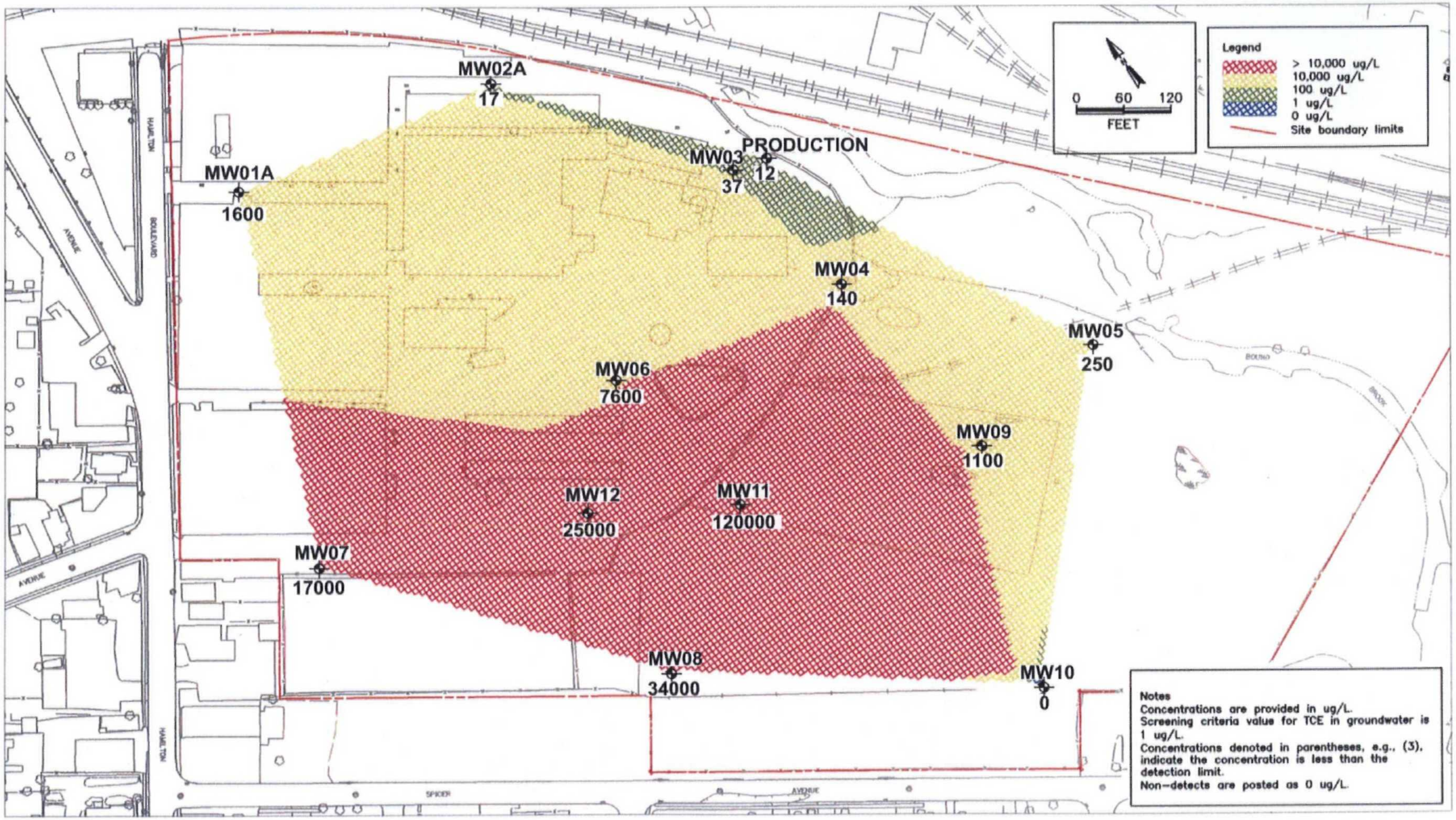
Source: "Remedial Investigation for Operable Unit 2, Cornell-Dubilier Electronics, Inc. Superfund Site. Foster Wheeler Environmental Corporation, August 2001.

Figure 2

PCB's in Shallow Bedrock Groundwater

Cornell-Dubilier Site
South Plainfield, NJ

HydroQual, Inc.



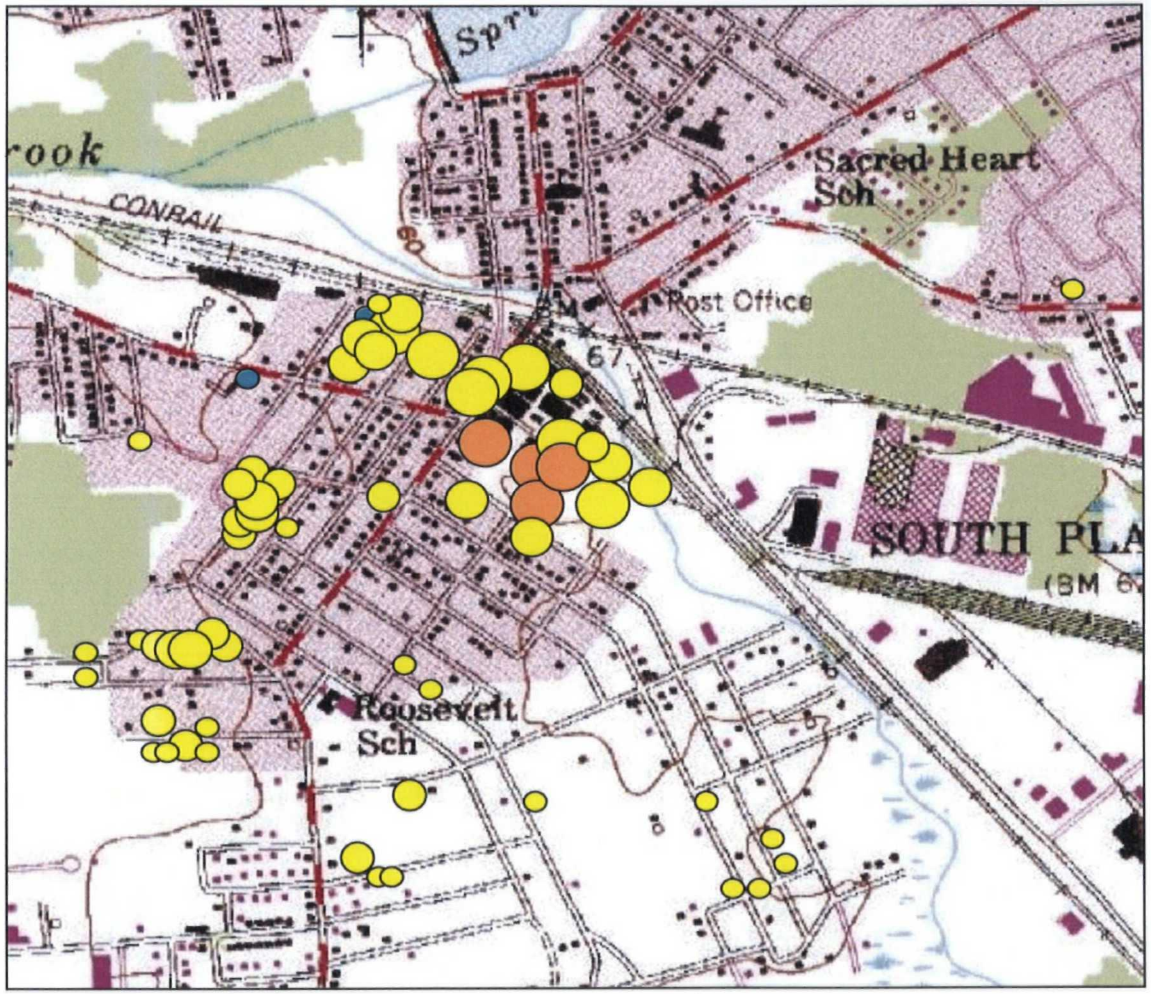
Source: "Remedial Investigation for Operable Unit 2, Cornell-Dubilier Electronics, Inc. Superfund Site. Foster Wheeler Environmental Corporation, August 2001.

Figure 3

VOC's in Shallow Bedrock Groundwater

Cornell-Dubilier Site
South Plainfield, NJ

HydroQual, Inc.



LEGEND

TCE Levels

- **<1.0 ug/l**
- **1.0-10 ug/l**
- **10-100 ug/l**
- **100-1,000 ug/l**
- **1,000-10,000 ug/l**
- **>10,000 ug/l**

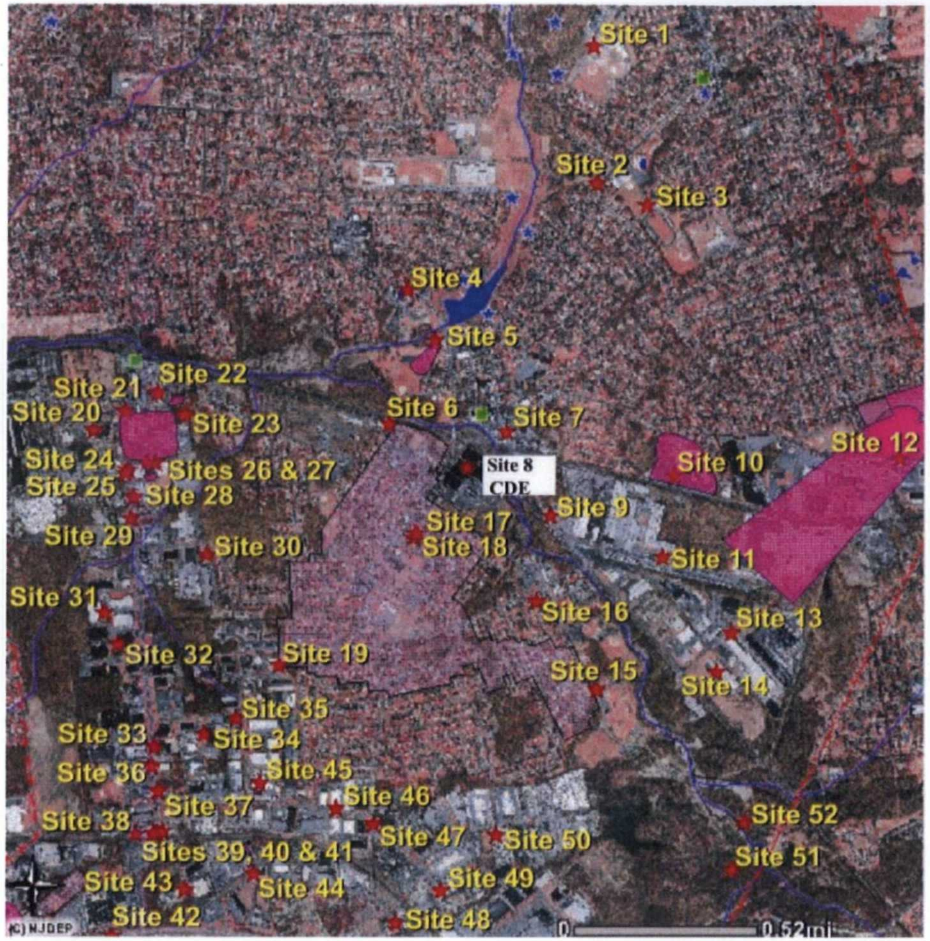
FIGURE 4

TCE Levels in Bedrock Groundwater

Cornell-Dubilier Site
South Plainfield, NJ

HydroQual, Inc.

Data taken from Plate 3 “Half-Mile Radius Ground Water Well Location Map, ENVIRON, 2/8/05



NJDEP Mapped Known Contaminated Sites

1. South Plainfield Senior Citizens Center
2. Middlesex Water Co. Wellfield Contam.
3. Jost Field House
4. South Plainfield Borough
5. Shell Service Station South Plainfield
6. Crown Bullion & Refining Company
7. Nischwitz & Company
8. Cornell Dubilier Electronix Inc.
9. Itran Corporation
10. Halls Warehouse Corporation
11. CP Manufacturing Inc.
12. Asarco Inc.
13. United Steel Deck Company
14. Chevron Chemical Company Ortho Division
15. South Plainfield Sanitary Landfill
16. Board of Education Municipal Yard
17. Pitt Street Ground Water Contamination
18. BP Service Station South Plainfield Borough
19. Prosoco Company Inc.
20. Loose Leaf Industries Inc.
21. Degussa Huls Corporation
22. RAD Corporation
23. Kern Foam
24. Barclay Brand Corporation
25. Eco Pump Corporation
26. CF Motor Freight
27. Hmieleski Trucking
28. Degussa Huls Corporation
29. SGM Armtek Inc.
30. Alfred Conhagen Inc.
31. Flagship Cleaning Services Inc.
32. Federal International Chemicals
33. L & R Metal Treating Company
34. Therma Plate Corporation
35. Tevco Inc.
36. Degussa Huls Corporation
37. 4201 Clinton Avenue South
38. Brooks Industries Inc.
39. Brooks Industries
40. Ultrakleen Services Inc.
41. Platina Refining Labs
42. Mary Kay Cosmetics Inc.
43. Synergy Gas
44. Absolute Fire Protection Company Inc.
45. Snyder Foundation Inc.
46. Lynn Steel Corp.
47. Boro Auto Wreckers Inc.
48. Amoco Service Station South Plainfield
49. Crisdel Construction Company
50. Saint Johnsbury Truck Terminal
51. Woodbrook Road Capacitor Site
52. South Plainfield Superfund Site

Legend

- Known Contaminated Sites List (2001)
- Public Community Water Supply Wells
- Place Names
- Municipalities
- Counties
- Streams
- Water Bodies
- Deed Notice Areas
- Groundwater Contamination Areas (CEA)
- Groundwater Contamination Areas (CKE)
- Aerial Photos 2002
- New Jersey

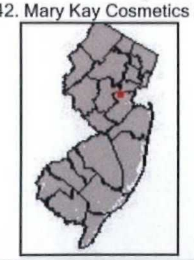


Figure 5

Location of Other Potential Sources

Cornell-Dubilier Site
South Plainfield, NJ

HydroQual, Inc.

4.3 CONTAMINANTS OF CONCERN

On the basis of existing data, the contaminants of concern related to groundwater include primarily VOCs and PCB's. More specifically, the VOCs of interest related to bedrock groundwater include the following:

Compound	Highest Concentration (ppb)	Location	Comments
TCE	100,000	MW-11 – CDE Site	Most common VOC*
PCE	3,800	MW-2D – Mary Kay	520 ppb at CDE
Vinyl Chloride	160	MW-01A – CDE Site	
Cis-1,2-DCE	160,000	MW-11 – CDE Site	
1,2,4-Trichlorobenzene	1200	MW-12 – CDE Site	Not reported elsewhere
Chloroform	36	450 Oak Tree Ave	Not reported at CDE
Carbon Tet.	7.6	450 Oak Tree Ave	Not reported at CDE
1,1,1-TCA	60	310 Pitt Street	Not reported at CDE
1,1-DCE	129	310 Pitt Street	Not reported at CDE
Toluene	180	111 Snyder Rd.	Not reported at CDE
MTBE	4.3	702 Hamilton	Not reported at CDE

* TCE is detected in wells throughout the area.

Other contaminants not specifically identified above were sporadically reported at various locations. However, the above list represents those most commonly reported, with TCE routinely detected throughout the area, followed by PCE (albeit less frequently). PCB's were also reported in bedrock groundwater in monitoring wells completed on the Site. PCB's have not been tested for during other studies performed outside the boundaries of the CDE property.

4.4 CONTAMINANT FATE AND TRANSPORT

The chlorinated solvents identified above as contaminants of concern, when introduced to the subsurface, will initially migrate as a dense non-aqueous phase liquid (DNAPL) independent of groundwater flow direction. The extent and direction of migration will depend on the volume of contaminant released to the subsurface, the density of the contaminant, the porosity of the surrounding soil and rock, fracture orientation, and solubility of the individual contaminants. At the Site, the principal constituents consist of chlorinated solvents (DNAPLs) which will tend to migrate along the top of lenses of lower permeability silt and clay materials and vertically downward along preferential pathways associated with bedrock fractures and bedding planes. As the chlorinated solvents migrate through the subsurface, the solvent coats the surrounding soil, is trapped within dead end fractures, and is adsorbed into the surrounding rock matrix, until the available mass is exhausted (i.e., all of the free product has been attenuated on soil particles, trapped in fractures or adsorbed into the rock matrix). Studies conducted at the University of Waterloo and at other sites suggest that in fractured sedimentary rock such as the Passaic Formation, the free product is adsorbed into the rock matrix within the course of several years. This research, plus experience at other sites underlain by the Passaic Formation, strongly suggests that most, if not all, of the DNAPL that entered the fractured rock are present as residual product trapped within the rock matrix, and that free product is no longer present.

This residual product, trapped within the rock matrix, serves as a long term, ongoing source of dissolved VOCs as they diffuse back out of the rock matrix and are dissolved into groundwater flowing through the bedrock. These dissolved VOCs are then transported with groundwater flow to downgradient locations. The dissolved VOCs are attenuated, to some degree, by adsorption into the surrounding rock matrix. In addition, under favorable conditions, biological and to some extent abiotic dechlorination can occur wherein the chlorine bonds within the VOC compounds are successively broken to form non-toxic compounds such as ethene and ethane. These mechanisms, along with advection and diffusion, serve to reduce the concentrations at the leading edges of the groundwater plume to drinking water standards and eventually to non-detectable levels of VOCs. There is evidence of dechlorination occurring at the Site as indicated by the presence of cis-1, 2-DCE in the groundwater, a constituent that is not a product of commerce and, therefore, indicates an in-situ dechlorination process.

PCBs are typically not very mobile in the subsurface in dissolved form due to their low solubility and their high partition coefficients, which make them tend to more readily adhere to the surrounding soil and rock matrix as opposed to being transported with groundwater. As a result, dissolved plumes of these compounds are typically less extensive than those associated with VOCs. However, the presence of solvents (VOCs) at high concentrations can enhance the solubility of PCB's and facilitate transport with groundwater to greater distances than would be expected without the presence of high concentrations of VOCs.

Given the above, as part of the identification of the Site as a source of off-site groundwater impact, one would expect to find the specific compound of interest at the highest concentration within the property boundaries. Although possible, free product is not anticipated nor has it been observed in work completed to date. Concentrations would then be expected to decline with distance along the downgradient flow path, with the extent of PCB impacts limited in comparison to the VOC plume. Concentrations detected outside the anticipated groundwater flow paths are likely associated with other sources unrelated to the Site. Likewise, compounds unrelated to the Site or at concentrations inconsistent with the surrounding concentration gradients, or in locations inconsistent with hydraulic gradients, would also be suggestive of an alternative source. As discussed previously, the available data suggest that other sources (of TCE and other VOCs) are present and that TCE impacts to groundwater may be part of a regional issue. However, the possibility also exists that groundwater flow paths may have varied over time, possibly because of variability of pumping for water supply, and such variability could also affect the understanding of source and distribution of contaminants. This possibility will be evaluated as additional data are collected.

4.5 CONTAMINANT VARIABILITY

As illustrated in Figure 4, and the table above, the concentration of the principal contaminant of concern, TCE, is highest at the Site. However, significant concentrations (100 ppb or greater) of TCE have also been detected to the west-southwest and southwest of the Site along Pitt Street and New York Ave, respectively. In addition, concentrations of TCE of less than 10 ppb are interspersed with these higher concentrations and at other locations throughout the surrounding area. Further, other VOCs such as MTBE, 1,1,1-TCA, and others, are detected at various locations throughout the surrounding area but not at the Site.

The widespread occurrence of TCE and the presence of VOCs that are not reported at the Site suggest the presence of other contaminant sources and a regional impact to groundwater unrelated to the Site. However, it is also important to recognize that some of the spatial variability could be related to historical groundwater flow patterns, as noted above. An understanding of groundwater use in the area, through time, will thus be a relevant consideration.

Variability in concentrations within short distances should also be anticipated in a fractured rock aquifer. The reported concentrations will depend on how well the fractures intercepted by any given well are hydraulically connected to the surrounding rock.

The variability of concentrations through time cannot be currently evaluated with the available data. Additional rounds of water quality samples will be collected as part of the Remedial Investigation, which will allow comparison to previously collected data.

4.6 CONTAMINANT SUSCEPTIBILITY TO TREATMENT

Various remedial alternatives exist to treat, in-situ or ex-situ, and/or contain the contaminants of concern identified at the Site. More specifically, dissolved VOCs, which are the principal contaminant of concern, can be addressed through conventional groundwater extraction and treatment with air stripping, activated carbon, and other technologies or in-situ treatment through enhanced bioremediation, air sparging, chemical oxidation, permeable reactive barriers, monitored natural attenuation, etc. Other constituents that may be present, such as SVOCs and PCBs, can also be treated by conventional means (e.g., carbon adsorption, chemical precipitation, filtration), but may be generally less amenable to in-situ treatment.

Several of the available technologies, such as permeable reactive barriers or thermally enhanced recovery, are generally not applicable to bedrock settings or to the depths likely required at this Site. More significantly, these technologies only treat the dissolved portion of the plume and do not address the long term, ongoing source of VOCs that have diffused into the rock matrix. At this time, there is currently no technology that is proven to address constituent mass in the rock matrix. Research is currently underway using permanganate (a long-lived oxidant) for oxidation of chlorinated alkanes and alkenes within the rock matrix by providing sufficient oxidant for diffusion into the matrix. However, to date, such technology has not been proven on a full-scale basis. The rate of mass reduction may ultimately be related solely to the rate of matrix diffusion, which has been shown to be on the order of hundreds of years. Remedial actions proposed for this Site must, therefore, address the issue of matrix diffusion as part of the Feasibility Study.

SECTION 5

EXPOSURE PATHWAYS AND RECEPTORS

Exposure pathways related to soil and dust have been addressed during previous remedial activities and are not addressed herein. Exposure pathways related to bedrock groundwater include exposure to VOC vapors migrating to indoor air from an underlying groundwater plume, exposure to volatile organic vapors from use of impacted groundwater, and ingestion of impacted groundwater. As noted previously, and to be further confirmed during the RI for OU-3, bedrock groundwater does not discharge to surface water. Therefore, the groundwater to surface water pathway is not complete. Potential receptors include individuals working or living (residents) in the area overlying groundwater containing elevated levels of VOCs (and to a lesser degree SVOCs and PCBs) and/or those that use impacted groundwater from private wells for drinking, cooking, bathing, irrigation, etc.

Exposure to VOC vapors can occur if groundwater containing elevated concentrations of VOCs is migrating beneath a structure and permeable unsaturated soils are present. The extent to which vapor migration impacts indoor air is related to VOC concentrations in the underlying groundwater, permeability and moisture content of the unsaturated zone soils, and construction of the dwelling. The presence of low permeability soils between the impacted groundwater and the dwelling significantly reduces or eliminates the potential for impacts to indoor air. Likewise, the presence of shallow uncontaminated groundwater overlying contaminated groundwater also precludes impact to indoor air.

Exposure to volatile organic vapors and/or ingestion of impacted water, can occur if impacted groundwater is pumped to the surface for typical use consisting of drinking, cooking, bathing, irrigation, etc. As a result of the NJDEP investigations completed in 1990, residences and businesses in the area were connected to public water supplies. Accordingly, this pathway has been addressed previously and private groundwater use is not expected. The nearest known use of groundwater is associated with the public water supply wells located north of the CDE Site near Spring Lake. An updated well inventory is currently underway, in accordance with Paragraph B. 6. of the Settlement Agreement, Statement of Work. As of the preparation of this preliminary CSM, well inventory data were not available from the New Jersey Department of Environmental Protection (NJDEP) and the Middlesex Water Company. As these data on water supply wells become available and work proceeds on the RI/FS, this preliminary CSM will be updated, as appropriate.

SECTION 6

CONCEPTUAL SITE MODEL (CSM)

The Conceptual Site Model (CSM) represents an evolving understanding of the Site hydrogeology, groundwater flow, and contaminant migration based upon the body of knowledge at any given time. At this time, the hydrogeologic setting and the current CSM are characterized by the following:

- The overburden in the area of the Site is relatively thin and largely unsaturated, and is comprised of low permeability soils.

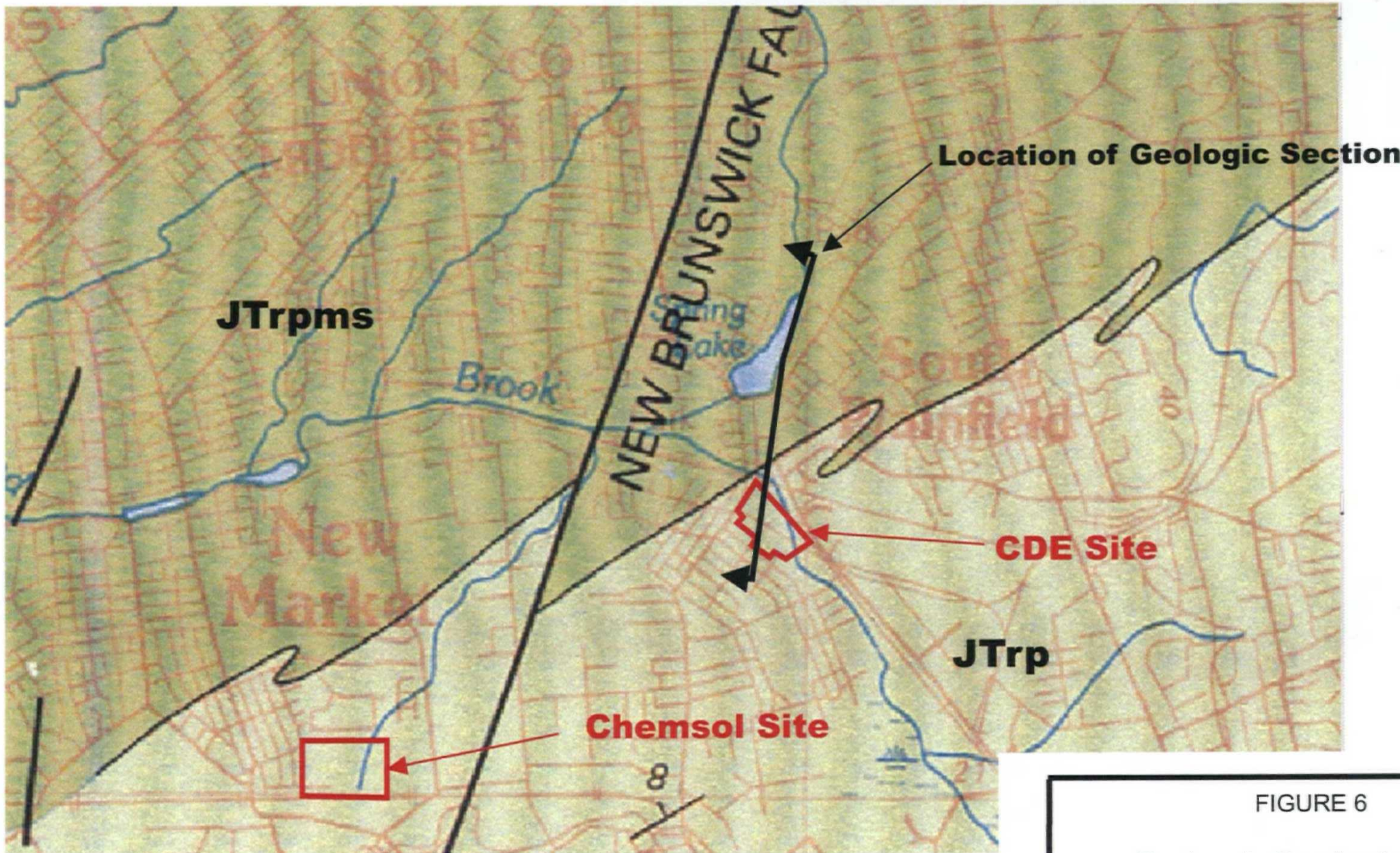
- The surface water elevation of the Bound Brook and surrounding wetlands is above the potentiometric surface of the underlying Passaic Formation bedrock and does not serve as a discharge point for bedrock groundwater. The likely ultimate discharge point for bedrock groundwater is represented by the extensive array of groundwater supply wells to the north.

- The Site is underlain by fractured rock of the Passaic Formation as illustrated in Figure 6. The rock in this area strikes roughly northeast/southwest and dips to the northwest at about 8 degrees.

- The upper 30 to 50 feet of the Passaic Formation is typically weathered and of generally low permeability. However, at greater depth, the Passaic Formation serves as a major water supply aquifer in the area. Numerous water supply wells are situated north of the Site along a broad swath of the aquifer south of the Watchung Ridge. These wells, along with their well head protection areas, are depicted on Figure 7. Pumping of these wells (rate, duration, zone/depth) can have a significant impact on groundwater flow direction.

- The closest of these water supply wells are the three Middlesex Water Company wells at Spring Lake. The southernmost of these wells are less than 2,000 feet from the Site. The location of these wells relative to the Site is illustrated in Figure 8, which depicts a northwest cross-section through the Site and the two water supply wells along the east side of Spring Lake.

- The Passaic Formation often exhibits a higher hydraulic conductivity along the direction of strike, which in this case is roughly northeast/southwest. This common characteristic of the Passaic Formation (as well as many other fractured rock



Legend

Mudstone Facies of Passaic fm

Passaic fm

8 Dip in Degrees

Strike of Formation

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FIGURE 6

Bedrock Geologic Map

Cornell-Dubilier Site
South Plainfield, NJ

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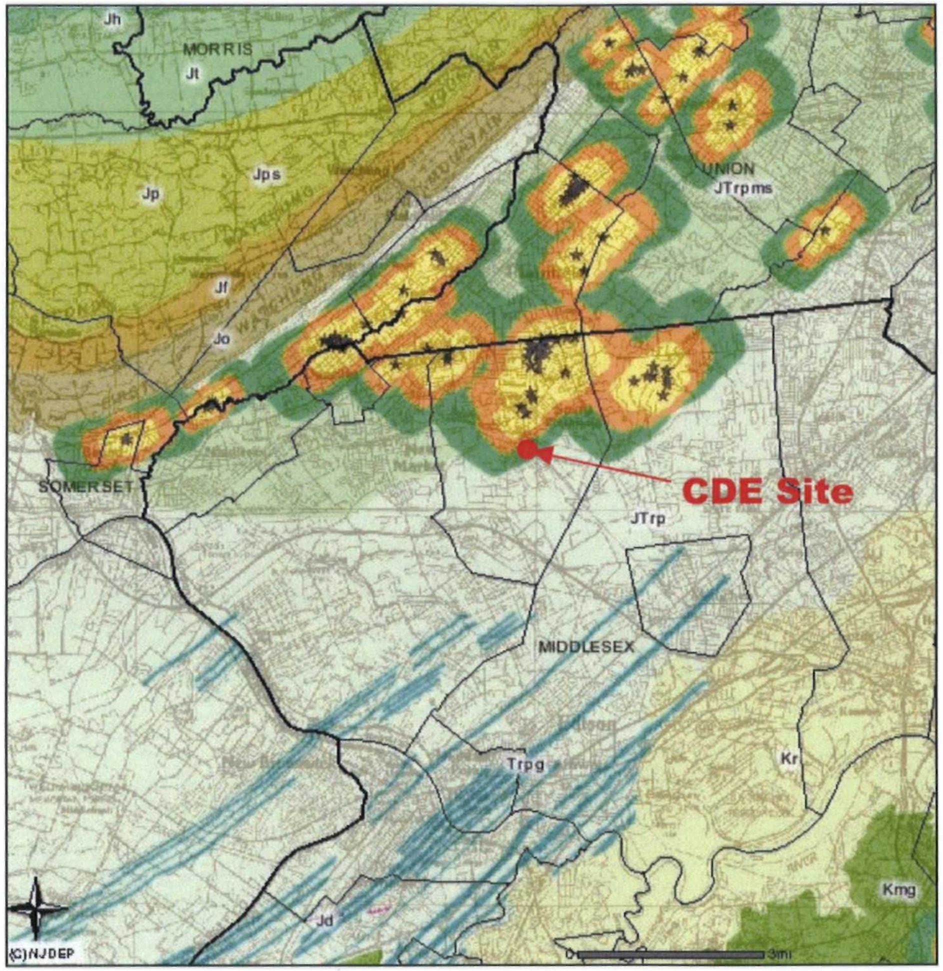

LEGEND:

★ Water Supply Wells

Well Head Protection Areas:

- 2-year zone of capture
- 5-year zone of capture
- 12-year zone of capture

FIGURE 7

CDE Site Location Relative to Major Water Supply Wells and Well Head Protection Areas

Cornell-Dubilier Site
South Plainfield, NJ

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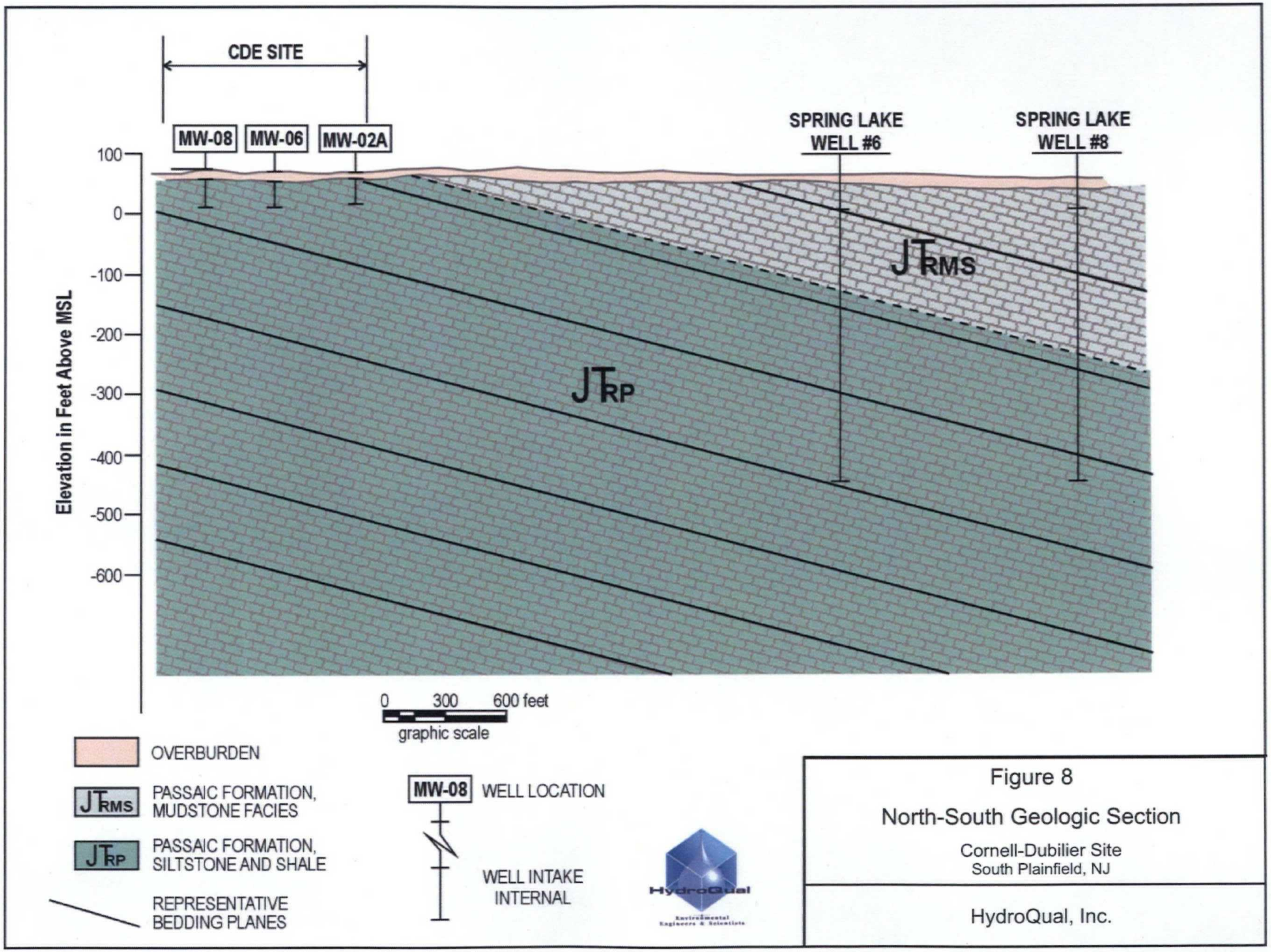

Figure 8

North-South Geologic Section

Cornell-Dubilier Site
South Plainfield, NJ

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aquifers) is referred to as areal anisotropy and is an important factor in controlling groundwater flow direction in this aquifer. As described in greater detail below, the magnitude of this anisotropy is an important factor in understanding groundwater flow direction.

- The Passaic Formation is composed of porous sandstone, shale and mudstone. Consequently, matrix diffusion of contaminants into and out of the rock's matrix will be a key factor governing contaminant migration in this formation.

- TCE and other solvents are widespread within the Passaic Formation aquifer in this area as discussed previously in Section 4.0. While the Site exhibits significant levels of TCE in its groundwater monitoring well network, there are also significant outlying areas of TCE contamination, and other solvents, in former private water supply wells. The source(s) of these outlying areas of contamination is unclear at this point and their relationship to the contaminants emanating from the Site will be clarified during the RI/FS.

6.1 PRELIMINARY GROUNDWATER FLOW MODELING

A preliminary groundwater flow model has been developed to provide insight into the hydrodynamics of the aquifer and the key parameters that govern groundwater flow and contaminant transport. Although unrefined at this time, completion of a preliminary groundwater flow model prior to conducting the site hydrogeologic investigation provides valuable insight to assess key data needs and to further the understanding of the CSM. Based on existing data collected from the Site, as well as data from the Chemsol Superfund Site located approximately 1.5 miles to the west, a preliminary model has been developed using Visual MODFLOW-Pro developed and marketed by Waterloo Hydrologic.

The groundwater flow model domain is illustrated in Figure 9. The model domain is 20,000 ft x 20,000 ft and has been oriented in a roughly northwest direction to align the model rows with the general direction of the strike of the bedrock. This facilitates modeling of the expected areal anisotropy of the rock. The model domain has been sized to include a number of the water supply pumping wells lying to the north and northwest of the Site, as well as the Chemsol Site to the west, as illustrated in Figure 10. The model grid consists of 118 rows, 125 columns, and consists of four layers extending to a depth of 700 feet below mean sea level. This was done to permit modeling of the deep water supply wells. In total, the model consists of 59,000 cells. Significant rivers and lakes such as the Bound Brook and Spring Lake were incorporated into the model. Recharge to the fractured rock aquifer was

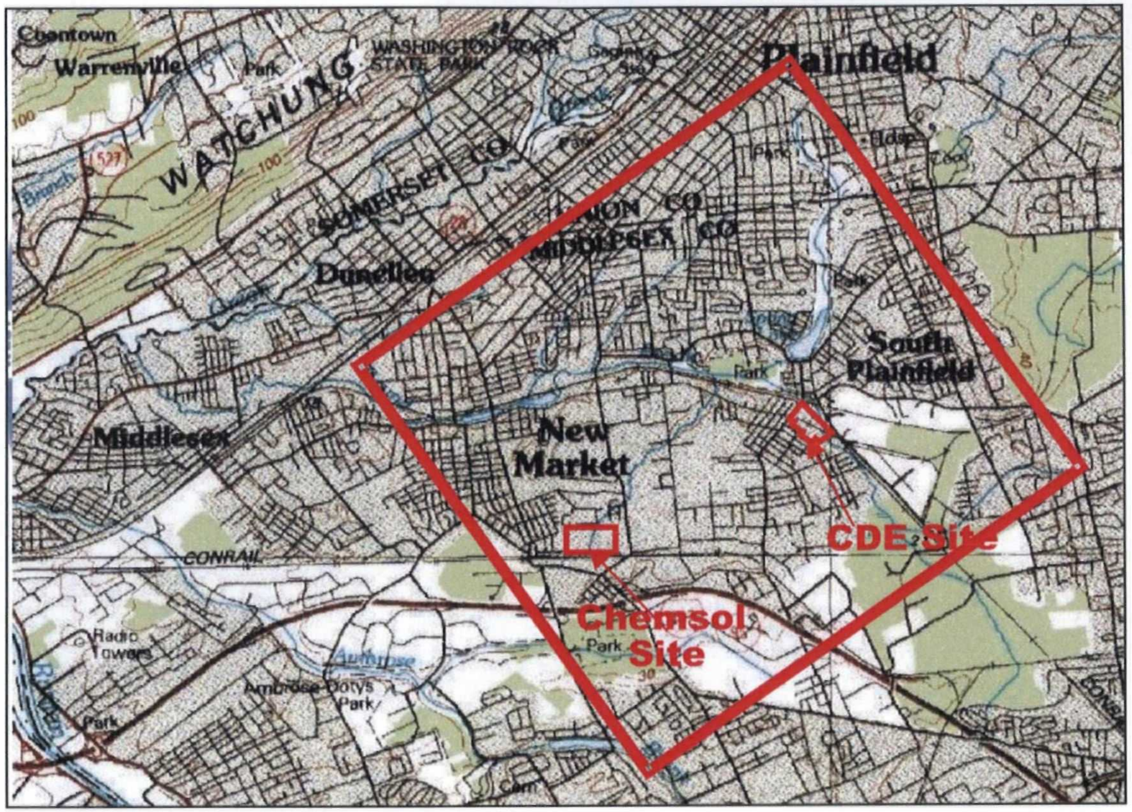

FIGURE 9

Groundwater Flow Model Domain

Cornell-Dubilier Site
South Plainfield, NJ

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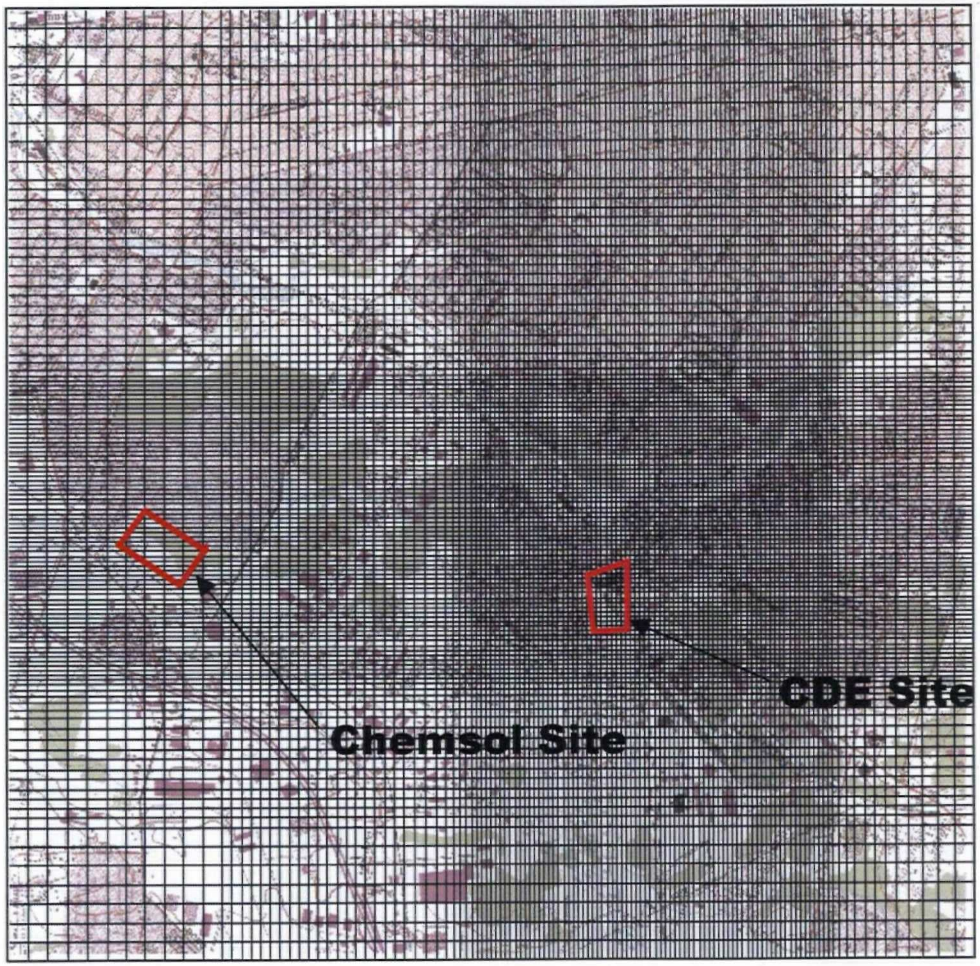

118 Rows

125 Columns

4 Layers

59,000 Cells

FIGURE 10

Groundwater Flow Model
Finite-Difference Grid

Cornell-Dubilier Site
South Plainfield, NJ

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set up uniformly as 5 inches per year, which represents recharge from the surficial overburden to the underlying fractured rock.

The model was calibrated using the average of the two rounds of groundwater levels taken at the Site in October 2000 and a non-pumping set of water levels taken at approximately the same time period at the Chemsol Superfund Site. Notwithstanding its preliminary nature, the model matches water levels on the two sites to quite close tolerances. The absolute residual mean differential between observed and simulated water levels in monitoring wells on the two sites is less than 0.40 feet. Groundwater flow directions are also similar to those observed on each site.

The following observations and insights have been gained through this preliminary modeling exercise:

- The hydrogeologic regime in the area of the Site is strongly influenced by the array of major water supply wells lying generally north of the Site. Modeling indicates that any significant variations in pumping rates of these wells, particularly those closer to the Site, produce major alterations in groundwater flow patterns in the rock aquifer beneath and around the Site. For example, Figure 11 shows projected groundwater flow paths from the Site, as well as a number of the surrounding sites with known groundwater contamination. In this simulation, the water supply wells are pumping at their reported yields and the areal anisotropy of the aquifer is set to nine. As previously noted, the Passaic Formation exhibits a higher hydraulic conductivity parallel to strike. An areal anisotropy of nine indicates that the hydraulic conductivity is nine times higher along strike than perpendicular to strike, as noted on Figure 11. The figure illustrates that groundwater originating at sites that lie well to the south and west of the Site flow past the Site through areas noted as having TCE in groundwater, as indicated by the bubble plots of TCE concentrations superimposed on Figure 11. As a point of reference, note that in this simulation, the flow lines originating from the South Plainfield Sanitary Landfill actually flow beneath the Site.

- Contrast this simulation with the simulation presented in Figure 12. In this simulation, the pumping rate of the two Spring Lake water supply wells closest to the Site (Spring Lake Wells No. 5 and No. 6) have been reduced to one-half of their reported yields. The effect on the groundwater flow system is dramatic. Flow lines are diverted in a much more westerly trajectory. As a point of reference, flow lines originating at the South Plainfield Sanitary Landfill now flow well to the west of the Site through a number of areas of known TCE contamination before ultimately reaching the water supply wells. The sensitivity of the flow system to changes in well pumping is further illustrated in Figure 13. In this case, the two Spring Lake wells closest to the Site (Spring Lake Wells No. 5 and No. 6) are shut down altogether. The effect on the flow system is again quite significant. Flow lines from potential off-site sources are diverted well west of the Site.

- In addition to illustrating the dynamic nature of the groundwater flow system in this area and the importance of the nearby water supply wells, the modeling also indicates that there could be other sources contributing to the observed TCE contamination in the vicinity of the Site, which sources are associated with a number of facilities lying to the south and west of the Site itself. Further research is needed to ascertain whether these facilities represent significant contributors to the observed groundwater impacts.

- The preliminary groundwater flow modeling also underscores the importance of defining the hydraulic conductivity parameters of the aquifer, most notably, the aquifer's areal anisotropy. Anisotropy in the Passaic Formation has been observed to range from as low as one (isotropic) to more common values ranging from five to ten, but also to as high as 22. The model was calibrated with an areal anisotropy of nine oriented parallel to strike. An anisotropy of this magnitude is quite common in the Passaic Formation and was suggested by the calibration efforts. However, to illustrate the importance of areal anisotropy in controlling groundwater flow directions, consider the flow paths presented in Figures 14 and 15. In Figure 14, the areal anisotropy has been reduced to six while the water supply wells have been reset to the baseline condition of pumpage at their reported yield. As can be seen in Figure 14, flow lines with an areal anisotropy of six, flow more easterly toward the water supply wells. As a point of reference, the flow lines originating from the South Plainfield Sanitary Landfill now flow to the east of the Site. Adjusting the areal anisotropy to 3, as illustrated in Figure 15, only accentuates this more easterly flow pattern. As noted on Figure 15, flow lines originating from the South Plainfield Sanitary Landfill now flow well east of the Site.

In summary, completion of the preliminary groundwater flow modeling has provided a number of useful insights into the nature of this hydrogeologic system and identified key data needs as summarized below:

1. Groundwater flow patterns in the Passaic Formation aquifer are likely strongly controlled and influenced by the pumping of nearby water supply wells, most

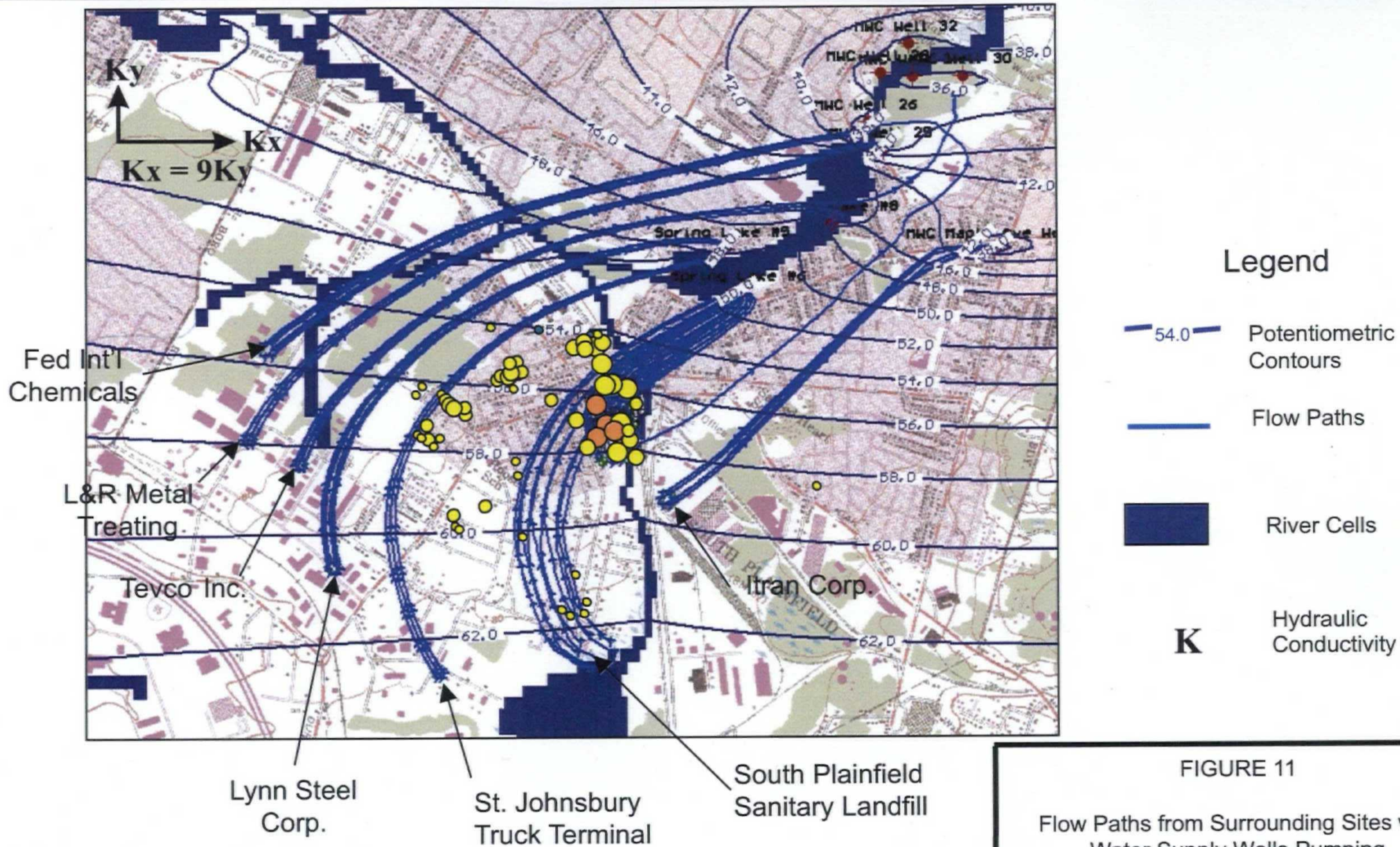

FIGURE 11

Flow Paths from Surrounding Sites with Water Supply Wells Pumping at their Yields and Areal Anisotropy = 9

Cornell-Dubilier Site
South Plainfield, NJ

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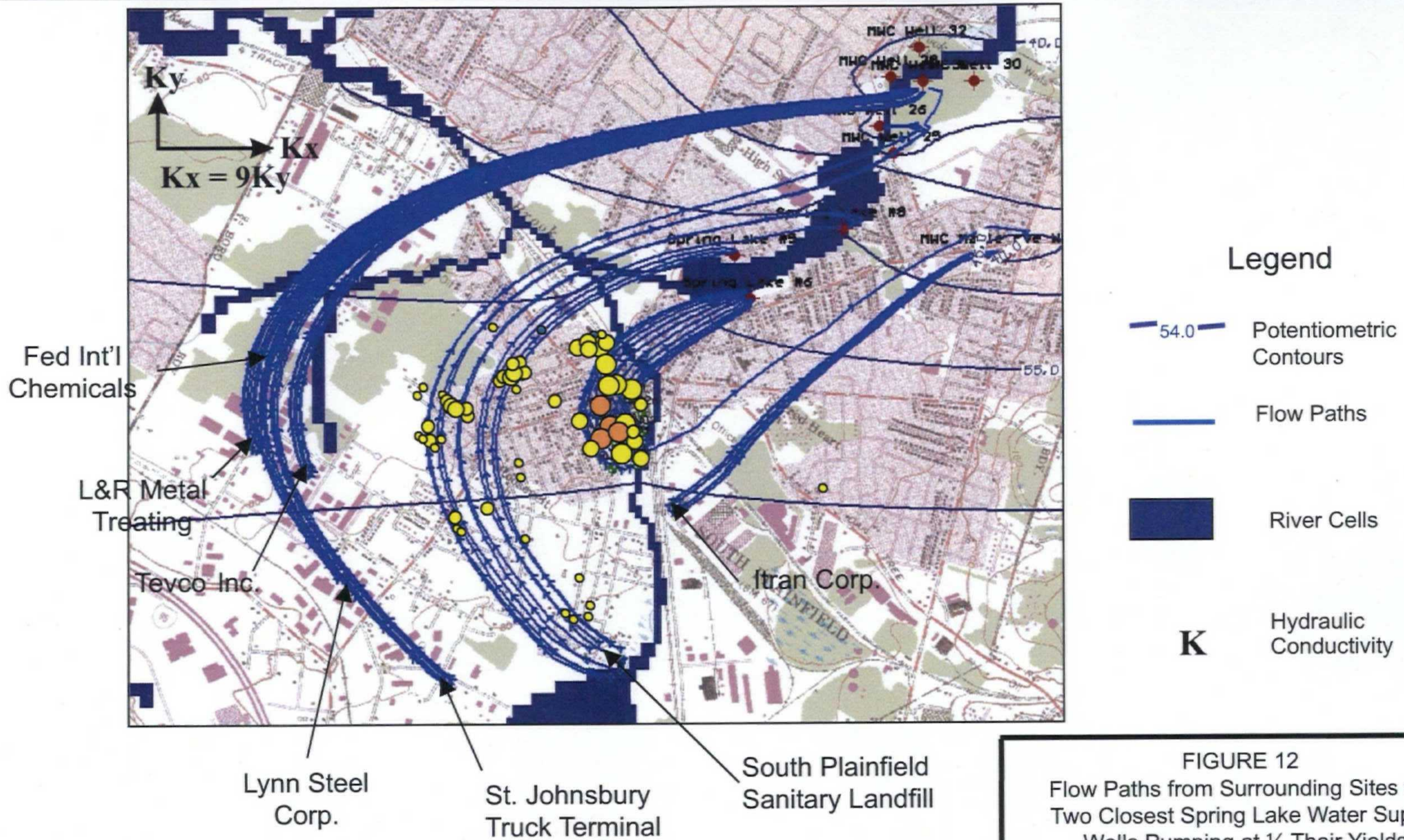

FIGURE 12
Flow Paths from Surrounding Sites with Two Closest Spring Lake Water Supply Wells Pumping at ½ Their Yields and Areal Anisotropy = 9

Cornell-Dubilier Site
South Plainfield, NJ

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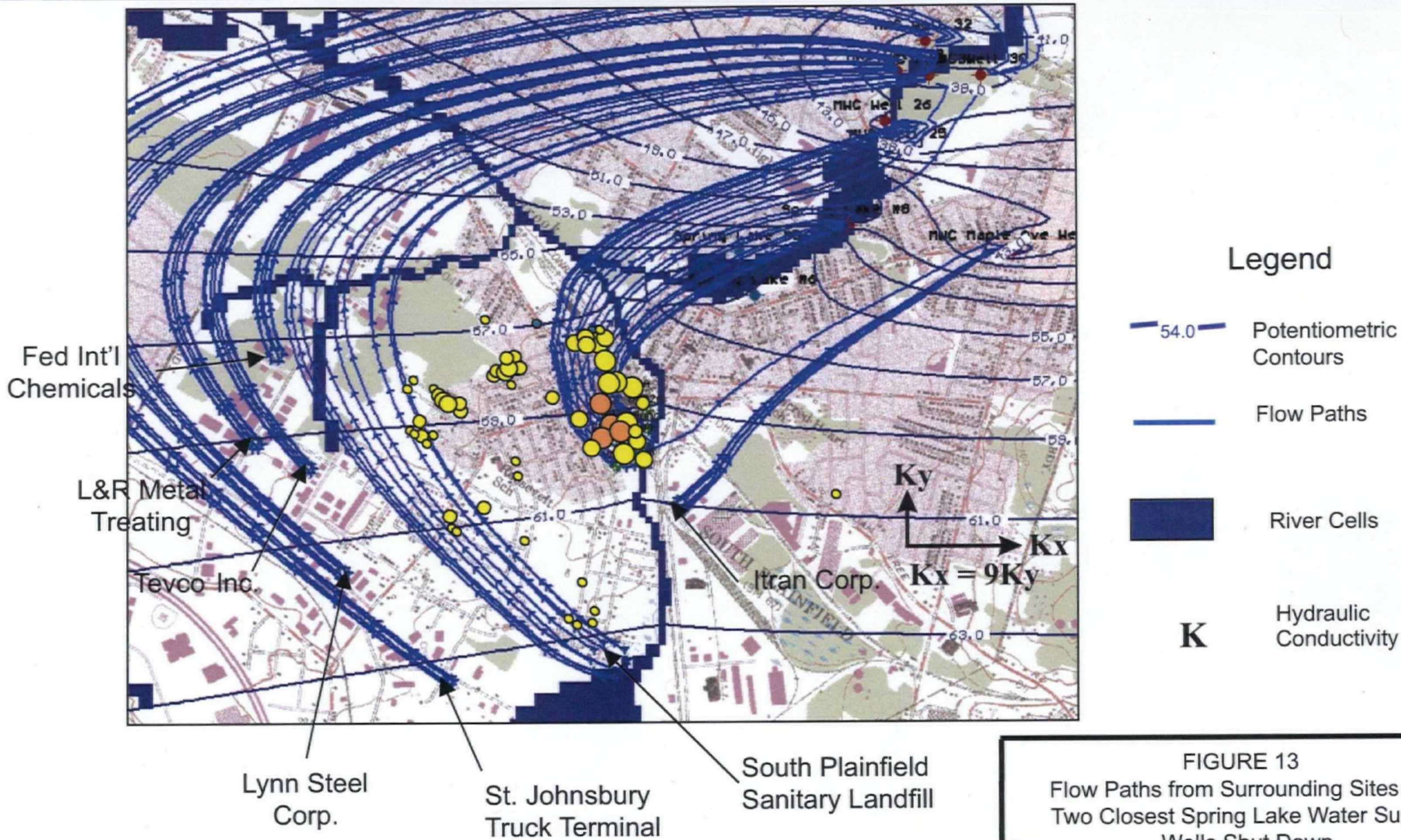

FIGURE 13
Flow Paths from Surrounding Sites with Two Closest Spring Lake Water Supply Wells Shut Down and Areal Anisotropy = 9

Cornell-Dubilier Site
South Plainfield, NJ

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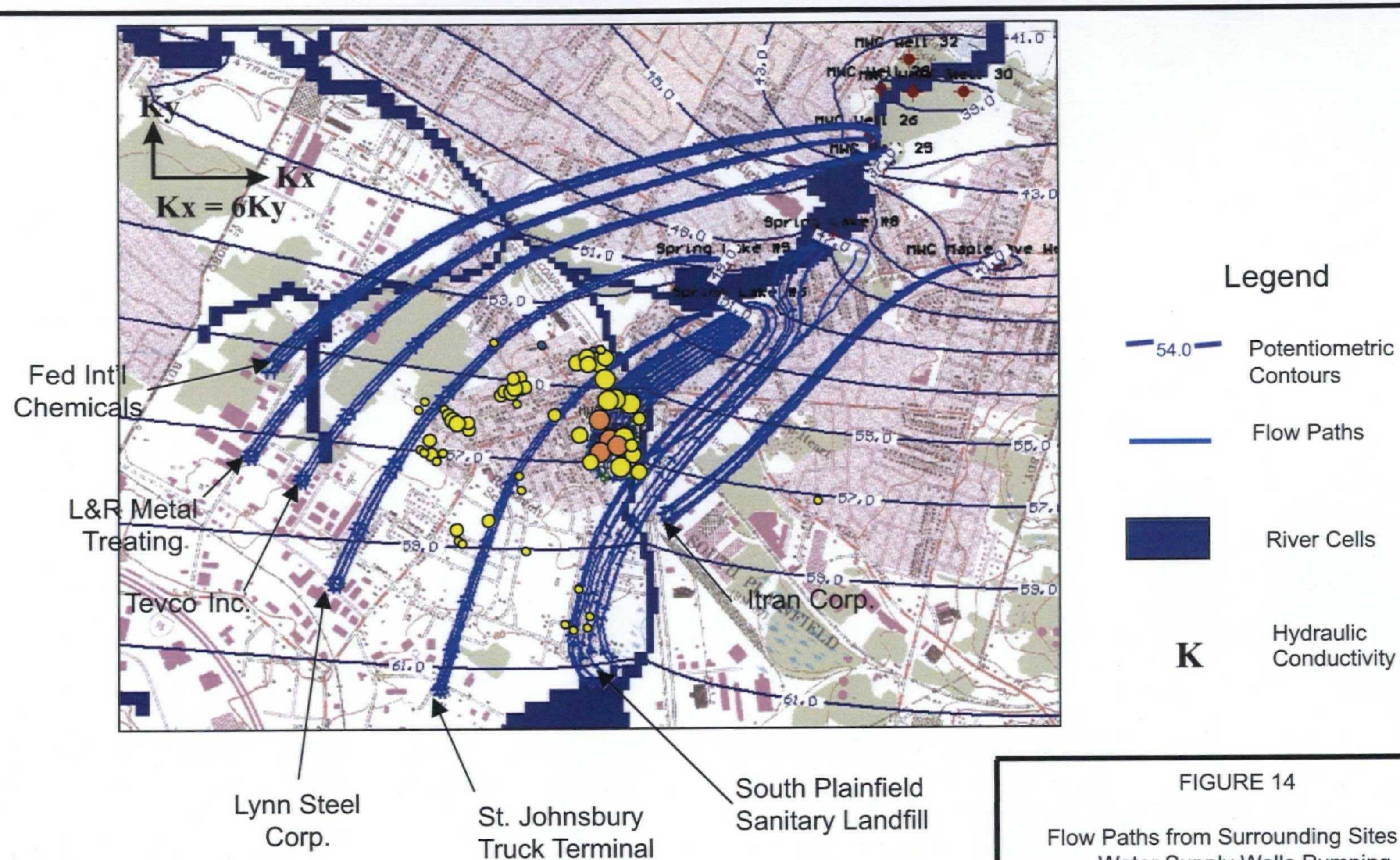

FIGURE 14

Flow Paths from Surrounding Sites with Water Supply Wells Pumping at their Yields and Areal Anisotropy = 6

Cornell-Dubilier Site
South Plainfield, NJ

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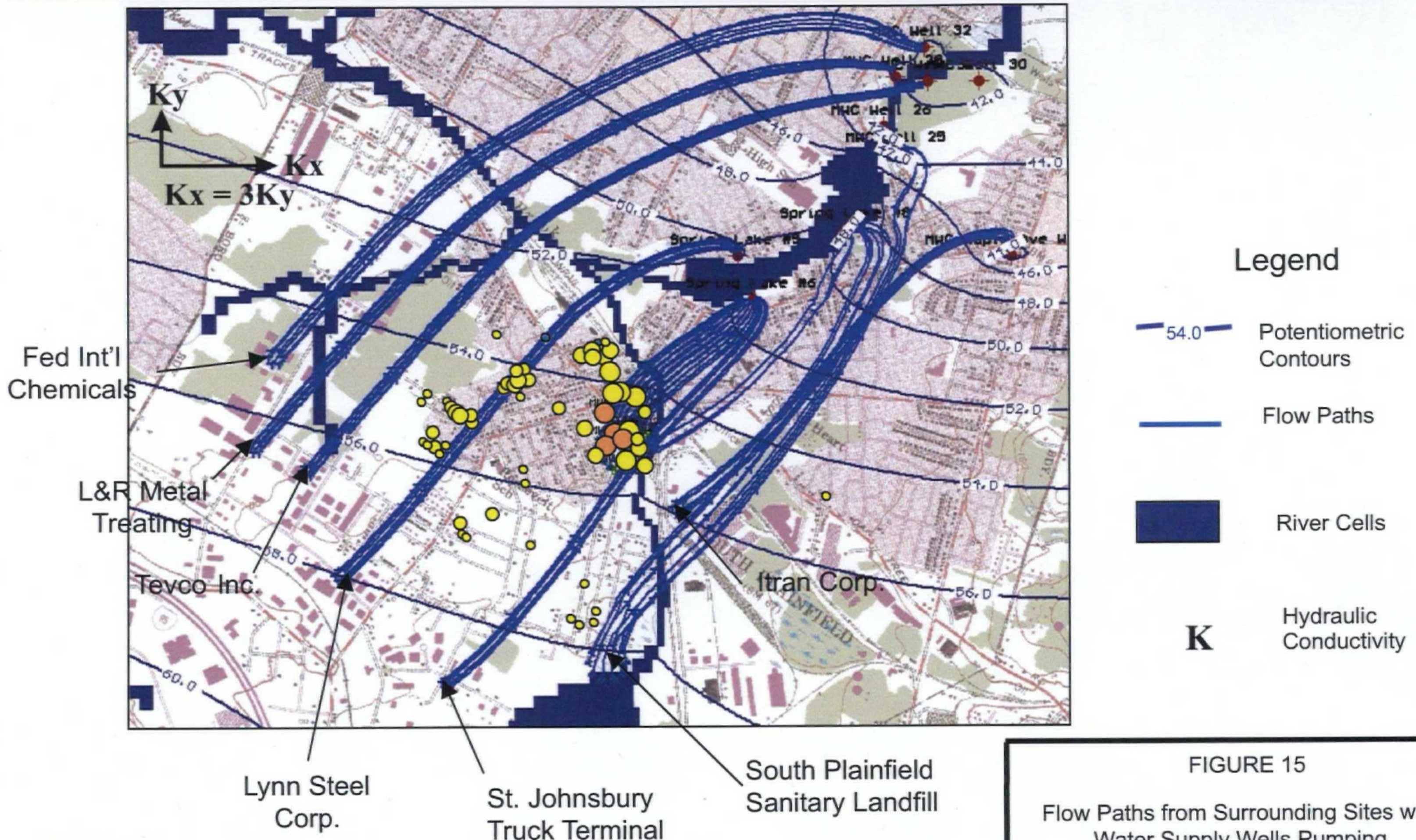

FIGURE 15

Flow Paths from Surrounding Sites with Water Supply Wells Pumping at their Yields and Areal Anisotropy = 3

Cornell-Dubilier Site
South Plainfield, NJ

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notably those at Spring Lake. However, before conclusions are drawn, the use, pumping duration, and pumping rates of these wells must be confirmed.

2. The areal anisotropy of the Passaic Formation aquifer is a critical parameter in understanding groundwater flow patterns in the rock. In particular, an understanding of areal anisotropy is paramount to discerning potential source areas for contamination.

The preliminary groundwater flow model will be updated as new information is obtained during the Remedial Investigation and will continue to be used as a tool in developing a quantitative understanding of the hydrogeologic system and assessing which hydrogeologic factors govern its behavior. As previously noted, a well records search is underway and, in late July 2005, a request was made to Middlesex Water Company for information regarding the municipal water supply wells to the north of the Site and a well records search was requested from NJDEP to assist in identifying water supply wells in the surrounding area. Billing records were also requested from Middlesex Water Company in an effort to identify any properties that may still be using a private well for their water supply. The location and rates of groundwater withdrawal will be input to the model, along with hydrogeologic parameters obtained during the Remedial Investigation, to further enhance the understanding of groundwater flow patterns.

SECTION 7

DATA NEEDS

On the basis of the current CSM and understanding of the Site hydrogeology and contaminant distribution, the following specific data needs have been identified as key aspects of the upcoming Remedial Investigation.

- Assessment of the current and historical groundwater use in the vicinity of the Site. This work is currently underway and the Middlesex Water Company and NJDEP have been contacted with requests for information.

- Assessment of the anisotropy of the Passaic Formation in the vicinity of the CDE Site and its impact on groundwater flow direction.

- Assessment of the hydrogeologic parameters of transmissivity, storativity, hydraulic gradients and fracture orientation.

- Identification of the current and historical (if different) groundwater flow direction.

- Assessment of vertical hydraulic gradients and the presence/absence of aquitards.

- Assessment of the vertical and horizontal distribution of contaminants of concern.

- Assessment of the pore water concentration of VOCs in the rock matrix and the potential implications of matrix diffusion as it relates to remedial alternatives.

- Assessment of the potential for vapor intrusion into businesses and homes overlying the dissolved groundwater plume.

The data needs noted above will be considered in the planning phases of the work to be performed for the Remedial Investigation, consistent with the requirements of the Settlement Agreement.

SECTION 8

REFERENCES

United State Environmental Protection Agency (USEPA), Record of Decision - Operable Unit Two, Cornell-Dubilier Electronics, Inc. Superfund Site South Plainfield, Middlesex County, New Jersey, September 2004.

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